civil engineering
structural design
land surveying

WYNN ENGINEERING

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3-19-08

STORM WATER MANAGEMENT PLAN FOR PRIORITY PROJECTS (MAJOR SWMP)

SAN DIEGO COUNTY PROJECT NUMBER: R04-017
LOG NUMBER: 04-09-014

VALLEY VIEW CASINO
PARKING LOT

For:
WEI JOB NUMBER: 05-060
SAN PASQUAL CASINO DEVELOPMENT GROUP
MR. JOE NAVARO
16300 NYEMII PASS ROAD
VALLEY VENTER, CALIFORNIA 92082

ORIGINAL DATE: MARCH 19, 2008

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PROJECT NUMBER R04-017, LOG NUMBER 04-09-014
COUNTY OF SAN DIEGO STORM WATER MANAGEMENT PLAN FOR PRIORITY PROJECTS – (MAJOR SWMP)

Project Name:	Valley View Casino Employee Parking Lot
Permit Number (Land Development Projects):	R04-017
Work Authorization Number (CIP):	
Applicant:	San Pasqual Casino Development Group, Inc. San Pasqual Band of Mission Indians
Applicant's Address:	San Pasqual Casino Development Group, Inc. San Pasqual Band of Mission Indians 16300 Nyemii Pass Road Valley Center , CA 92082
Plan Prepared By (*Leave blank if same as applicant*):	Wynn Engineering, Inc. 27315 Valley Center Road Valley Center, CA 92082
Date:	March 19, 2008
Revision Date (If applicable):	

The County of San Diego Watershed Protection, Storm Water Management, and Discharge Control Ordinance (WPO) (Ordinance No. 9424) requires all applications for a permit or approval associated with a Land Disturbance Activity must be accompanied by a Storm Water Management Plan (SWMP) (section 67.804.f). The purpose of the SWMP is to describe how the project will minimize the short and long-term impacts on receiving water quality. Projects that meet the criteria for a priority project are required to prepare a Major SWMP.

Since the SWMP is a living document, revisions may be necessary during various stages of approval by the County. Please provide the approval information requested below.

Project Review Stage	Does the SWMP need revisions?		If YES, Provide Revision Date
	YES	NO	
Site Plan			

Completion of the following checklist and attachments will fulfill the requirements of a Major SWMP for the project listed above.

PROJECT DESCRIPTION

The project site is located in the southwest corner of the intersection of Valley Center Road and Lake Wohlford Road in the Valley Center planning area of the County of San Diego (See Attachment A). This project consists of a rezone from the A70, Limited Agricultural Use Regulation to the S86 Parking Use Regulation to allow a remote paved parking lot for the Valley View Casino located on the San Pasqual Reservation.

The purpose of this SWMP is to address the water quality impacts from the proposed ~~overflow~~ employee parking lot on APN 189-051-02. Low Impact, Non-Structural and Structural Best Management Practices (BMPs) will be utilized to provide a long-term solution to water quality. This SWMP is also intended to ensure the effectiveness of the BMPs through proper maintenance that is based on long-term fiscal planning. The SWMP is subject to revisions as needed by the engineer.

PRIORITY PROJECT DETERMINATION

Please check the box that best describes the project. Does the project meet one of the following criteria?

PRIORITY PROJECT	YES	NO
Redevelopment within the County Urban Area that creates or adds at least 5,000 net square feet of additional impervious surface area		***X***
Residential development of more than 10 units		***X***
Commercial developments with a land area for development of greater than 100,000 square feet		***X***
Automotive repair shops		***X***
Restaurants, where the land area for development is greater than 5,000 square feet		***X***
Hillside development, in an area with known erosive soil conditions, where there will be grading on any natural slope that is twenty-five percent or greater, if the development creates 5,000 square feet or more of impervious surface		***X***
Environmentally Sensitive Areas: All development and redevelopment located within or directly adjacent to or discharging directly to an environmentally sensitive area (where discharges from the development or redevelopment will enter receiving waters within the environmentally sensitive area), which either creates 2,500 square feet of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site to 10% or more of its naturally occurring condition.		***X***
Parking Lots 5,000 square feet or more or with 15 parking spaces or more and potentially exposed to urban runoff	***X***	
Streets, roads, highways, and freeways which would create a new paved surface that is 5,000 square feet or greater		***X***

Based on the above, this is a priority project.

The following questions were used to collect information relevant to project stormwater quality issues:

	QUESTIONS	COMPLETED	N/A
1.	Describe the topography of the project area.	X	
2.	Describe the local land use within the project area and adjacent areas.	X	
3.	Evaluate the presence of dry weather flow.	X	
4.	Determine the receiving waters that may be affected by the project throughout the project life cycle (i.e., construction, maintenance and operation).	X	
5.	For the project limits, list the 303(d) impaired receiving water bodies and their constituents of concern.	X	
6.	Determine if there are any High Risk Areas (municipal or domestic water supply reservoirs or groundwater percolation facilities) within the project limits.	X	
7.	Determine the Regional Board special requirements, including Total Maximum Daily Loads (TMDLs), effluent limits, etc.	X	
8.	Determine the general climate of the project area. Identify annual rainfall and rainfall intensity curves.	X	
9.	If considering Treatment BMPs, determine the soil classification, permeability, erodibility, and depth to groundwater.	X	
10.	Determine contaminated or hazardous soils within the project area.	X	

The following is a description of the findings from the table above:

Site Topography – The project site is located in the southwest corner of the intersection of Valley Center Road and Lake Wohlford Road in the Valley Center planning area of the County of San Diego (See Attachment A). The existing topography is relatively flat.

Site Land Use - This project consists of a rezone from the A70, Limited Agricultural Use Regulation to the S86 Parking Use Regulation to allow a remote paved parking lot for the Valley View Casino located on the San Pasqual Band of Mission Indians Reservation.

Dry Weather Flows – There is no evidence of dry weather flow on the project site.

Receiving Waters – The Project site is located at the approximate middle of the eastern boundary of the Rincon Hydrologic Subarea (903.16) of the San Luis Rey Hydrologic Unit (903.00).

303(d) Statement – The Rincon HSA is not listed on the current 303(d) lists for Impaired Water Bodies.

continued below…

Water Facilities – There are not municipal or domestic water supply reservoirs or groundwater percolation facilities on or adjacent to the project site.

303(d) TDML – The Rincon HSA is not listed on the current 303(d) lists for TDMLs.

Annual Rainfall – Rainfall data and quantities have been determined in the project's drainage study titled 'Preliminary Drainage Study' by Wynn Engineering, Inc. dated March 5, 2008. This Preliminary Drainage Study is a separate document and is also part of San Diego County Project Number R04-17, Log Number 04-09-014.

Soil Classification - The project area consists of soil group C. All information regarding research on soil type is contained in the project's drainage study titled 'Preliminary Drainage Study' by Wynn Engineering, Inc. dated March 5, 2008. This Preliminary Drainage Study is a separate document and is also part of San Diego County Project Number R04-17, Log Number 04-09-014.

Hazardous Soils – There are not contaminated or hazardous soils within the project area.

The Checklist below will determine if Treatment Control Best Management Practices (BMPs) are required for the project:

No.	CRITERIA	YES	NO	INFORMATION
1.	Is this an emergency project		***X***	If YES, go to 6. If NO, continue to 2.
2.	Have TMDLs been established for surface waters within the project limit?		***X***	If YES, go to 5. If NO, continue to 3.
3.	Will the project directly discharge to a 303(d) impaired receiving water body?		***X***	If YES, go to 5. If NO, continue to 4.
4.	Is this project within the urban and environmentally sensitive areas as defined on the maps in Appendix B of the *County of San Diego Standard Urban Storm Water Mitigation Plan for Land Development and Public Improvement Projects*?		***X***	If YES, continue to 5. If NO, go to 6.
5.	Consider approved Treatment BMPs for the project.			If YES, go to 7.

No.	CRITERIA	YES	NO	INFORMATION
6.	Project is not required to consider Treatment BMPs			Document for Project Files by referencing this checklist.
7.	End			

Based on the above, Treatment Control BMPs are required for the project.

WATERSHED

The watershed(s) for the project are checked.

☐ San Juan	☐ Santa Margarita	☒ San Luis Ray	☐ Carlsbad
☐ San Dieguito	☐ Penasquitos	☐ San Diego	☐ Pueblo San Diego
☐ Sweetwater	☐ Otay	☐ Tijuana	

Hydrologic sub-area name and number(s)

Number	Name
903.16	Rincon HSA

The Beneficial Uses for Inland Surface Waters and Ground Waters within Influence of Site.

SURFACE WATERS	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN
Inland Surface Waters																
Rincon HSA	903.16	X	X	X					X	X		X		X		
Ground Waters																
n/a																

X Existing Beneficial Use
0 Potential Beneficial Use
* Excepted from Municipal

POLLUTANTS OF CONCERN

Table 1 identifies pollutants that are anticipated to be generated from the proposed priority project. Pollutants associated with any hazardous material sites that have been remediated or are not threatened by the proposed project are not considered a pollutant of concern.

Table 1. Anticipated and Potential Pollutants Generated by Land Use Type

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P	X
Commercial Development >100,000 ft^2	P(1)	P(1)		P(2)	X	P(5)	X	P(3)	P(5)
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft^2	X	X			X	X	X		X
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

This section intentionally left blank

CONSTRUCTION BMPs

The construction BMPs that will be used are selected as indicated in the following table.

☒ Silt Fence	☐ Desilting Basin
☒ Fiber Rolls	☒ Gravel Bag Berm
☒ Street Sweeping and Vacuuming	☐ Sandbag Barrier
☒ Storm Drain Inlet Protection	☒ Material Delivery and Storage
☒ Stockpile Management	☒ Spill Prevention and Control
☒ Solid Waste Management	☒ Concrete Waste Management
☒ Stabilized Construction Entrance/Exit	☒ Water Conservation Practices
☐ Dewatering Operations	☒ Paving and Grinding Operations
☒ Vehicle and Equipment Maintenance	
☐ Any minor slopes created incidental to construction and not subject to a major or minor grading permit shall be protected by covering with plastic or tarp prior to a rain event, and shall have vegetative cover reestablished within 180 days of completion of the slope and prior to final building approval.	

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LID & SITE DESIGN

The following checklist indicates the options chosen for avoiding or reducing potential impacts during project planning. A brief explanation is provided at the end for each NO or N/A response in the following the checklist.

		OPTIONS	YES	NO	N/A
1.	Can the project be relocated or realigned to avoid/reduce impacts to receiving waters or to increase the preservation of critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions?				*X*
2.	Can the project be designed to minimize impervious footprint?		*X*		
3.	Conserve natural areas where feasible?		*X*		
4.	Where landscape is proposed, can rooftops, impervious sidewalks, walkways, trails and patios be drained into adjacent landscaping?		*X*		
5.	For roadway projects, can structures and bridges be designed or located to reduce work in live streams and minimize construction impacts?				*X*
6.	Can any of the following methods be utilized to minimize erosion from slopes:				
	6.a.	Disturbing existing slopes only when necessary?	*X*		
	6.b.	Minimize cut and fill areas to reduce slope lengths?	*X*		
	6.c.	Incorporating retaining walls to reduce steepness of slopes or to shorten slopes?	*X*		
	6.d.	Providing benches or terraces on high cut and fill slopes to reduce concentration of flows?			*X*
	6.e.	Rounding and shaping slopes to reduce concentrated flow?	*X*		
	6.f.	Collecting concentrated flows in stabilized drains and channels?	*X*		

Explanation for each N/A or NO response and LID Explanation.

Project Relocation – The Project Site cannot be relocated. The site will be utilized as a parking lot with as much landscaping as possible, as defined on the landscape plans to maximize canopy interception and to direct parking lot drainage to vegetated buffers and a vegetated swale.

Roadway Projects – This is not a roadway project. The roads on the plans are already in existence.

Benching and Terracing – Project Slopes are not high enough to require benching or terracing.

continued below…

Low Impact Development (LID) Selection – Site Design also includes the use of LIDs. LID uses decentralized, site-based planning and design strategies to manage the quantity and quality of stormwater runoff. LID attempts to reduce the amount of runoff by mimicking the natural hydrologic function of the site. LID focuses on minimizing impervious surfaces and promoting infiltration and evaporation of runoff before it can leave the location of origination. Using small, economical landscape features, LID techniques work as a system to filter, slow, evaporate, and infiltrate surface runoff at the source.

The LIDs incorporated into the design of the project site are designed into a treatment train to better remove potential and anticipated pollutants of concern. The project site will utilize the following LID Fact Sheets from the County of San Diego Low Impact Development Handbook (current edition):

- Fact Sheet 3 – Extended Detention (dry) Pond
- Fact Sheet 4 – Vegetated Swale
- Fact Sheet 5 – Vegetated Filter Strips
- Fact Sheet 12 – Crushed Aggregate
- Fact Sheet 17 – Curb Cuts
- Fact Sheet 24 – LID Driveway, Sidewalk, and Bike Path Design

Fact Sheets 12 and 24 will be utilized on the meandering trail.

Fact Sheets 5 and 17 will be utilized in the parking areas to direct runoff to the landscaped areas. The runoff will then be transported in a vegetated swale per Fact Sheet 4 to a detention basin per Fact Sheet 3.

If the project includes work in channels, then the following checklist will also be used:

No.	CRITERIA	YES	NO	N/A	COMMENTS
1.	Will the project increase velocity or volume of downstream flow?			***X***	If YES go to 5.
2.	Will the project discharge to unlined channels?			***X***	If YES go to 5.
3.	Will the project increase potential sediment load of downstream flow?			***X***	If YES go to 5.
4.	Will the project encroach, cross, realign, or cause other hydraulic changes to a stream that may affect downstream channel stability?			***X***	If YES go to 7.
5.	Review channel lining materials and design for stream bank erosion.			***X***	Continue to 6.
6.	Consider channel erosion control measures within the project limits as well as downstream. Consider scour velocity.			***X***	Continue to 7.

No.	CRITERIA	*YES*	*NO*	*N/A*	COMMENTS
7.	Include, where appropriate, energy dissipation devices at culverts.			*X*	Continue to 8.
8.	Ensure all transitions between culvert outlets/headwalls/wingwalls and channels are smooth to reduce turbulence and scour.			*X*	Continue to 9.
9.	Include, if appropriate, detention facilities to reduce peak discharges.			*X*	
10.	"Hardening" natural downstream areas to prevent erosion is not an acceptable technique for protecting channel slopes, unless pre-development conditions are determined to be so erosive that hardening would be required even in the absence of the proposed development.			*X*	Continue to 11.
11.	Provide other design principles that are comparable and equally effective.			*X*	Continue to 12.
12.	End				

SOURCE CONTROL
The following checklist indicates the Source Control BMPs chosen for this project. If the BMP is not applicable for this project, then N/A is checked only at the main category.

		BMP	YES	NO	N/A
1.	**Provide Storm Drain System Stenciling and Signage**				*X*
	1.a.	All storm drain inlets and catch basins within the project area shall have a stencil or tile placed with prohibitive language (such as: "NO DUMPING – DRAINS TO ________") and/or graphical icons to discourage illegal dumping.			
	1.b.	Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the project area.			
2.	**Design Outdoors Material Storage Areas to Reduce Pollution Introduction**				*X*
	2.a.	This is a detached single-family residential project. Therefore, personal storage areas are exempt from this requirement.			
	2.b.	Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.			
	2.c.	The storage area shall be paved and sufficiently impervious to contain leaks and spills.			

BMP			YES	NO	N/A
	2.d.	The storage area shall have a roof or awning to minimize direct precipitation within the secondary containment area.			
3.	**Design Trash Storage Areas to Reduce Pollution Introduction**				*X*
	3.a.	Paved with an impervious surface, designed not to allow run-on from adjoining areas, screened or walled to prevent off-site transport of trash; or,			
	3.b.	Provide attached lids on all trash containers that exclude rain, or roof or awning to minimize direct precipitation.			
4.	**Use Efficient Irrigation Systems & Landscape Design**				
	The following methods to reduce excessive irrigation runoff shall be considered, and incorporated and implemented where determined applicable and feasible.				
	4.a.	Employing rain shutoff devices to prevent irrigation after precipitation.	*X*		
	4.b.	Designing irrigation systems to each landscape area's specific water requirements.	*X*		
	4.c.	Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.	*X*		
	4.d.	Employing other comparable, equally effective, methods to reduce irrigation water runoff.	*X*		
5.	**Private Roads**				*X*
	The design of private roadway drainage shall use at least one of the following				
	5.a.	Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings.			
	5.b.	Urban curb/swale system: street slopes to curb, periodic swale inlets drain to vegetated swale/biofilter.			
	5.c.	Dual drainage system: First flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to storm water conveyance system.			
	5.d.	Other methods that are comparable and equally effective within the project.			
6.	**Residential Driveways & Guest Parking**				*X*
	The design of driveways and private residential parking areas shall use at least one of the following features.				
	6.a.	Design driveways with shared access, flared (single lane at street) or wheelstrips (paving only under tires); or, drain into landscaping prior to discharging to the storm water conveyance system.			

BMP			YES	NO	N/A
	6.b.	Uncovered temporary or guest parking on private residential lots may be: paved with a permeable surface; or, designed to drain into landscaping prior to discharging to the storm water conveyance system.			
	6.c.	Other features which are comparable and equally effective.			
7.	**Dock Areas**				***X***
	Loading/unloading dock areas shall include the following.				
	7.a.	Cover loading dock areas, or design drainage to preclude urban run-on and runoff.			
	7.b.	Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.			
	7.c.	Other features which are comparable and equally effective.			
8.	**Maintenance Bays**				***X***
	Maintenance bays shall include the following.				
	8.a.	Repair/maintenance bays shall be indoors; or, designed to preclude urban run-on and runoff.			
	8.b.	Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.			
	8.c.	Other features which are comparable and equally effective.			
9.	**Vehicle Wash Areas**				***X***
	Priority projects that include areas for washing/steam cleaning of vehicles shall use the following.				
	9.a.	Self-contained; or covered with a roof or overhang.			
	9.b.	Equipped with a clarifier or other pretreatment facility.			
	9.c.	Properly connected to a sanitary sewer.			
	9.d.	Other features which are comparable and equally effective.			
10.	**Outdoor Processing Areas**				***X***
	Outdoor process equipment operations, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, waste piles, and wastewater and solid waste treatment and disposal, and other operations determined to be a potential threat to water quality by the County shall adhere to the following requirements.				
	10.a.	Cover or enclose areas that would be the most significant source of pollutants; or, slope the area toward a dead-end sump; or, discharge to the sanitary sewer system following appropriate treatment in accordance with conditions established by the applicable sewer agency.			
	10.b.	Grade or berm area to prevent run-on from surrounding areas.			

		BMP	**YES**	**NO**	**N/A**
	10.c.	Installation of storm drains in areas of equipment repair is prohibited.			
	10.d.	Other features which are comparable or equally effective.			
11.	**Equipment Wash Areas**				***X***
	Outdoor equipment/accessory washing and steam cleaning activities shall be.				
	11.a.	Be self-contained; or covered with a roof or overhang.			
	11.b.	Be equipped with a clarifier, grease trap or other pretreatment facility, as appropriate			
	11.c.	Be properly connected to a sanitary sewer.			
	11.d.	Other features which are comparable or equally effective.			
12.	**Parking Areas**				
	The following design concepts shall be considered, and incorporated and implemented where determined applicable and feasible by the County.				
	12.a.	Where landscaping is proposed in parking areas, incorporate landscape areas into the drainage design.	***X***		
	12.b.	Overflow parking (parking stalls provided in excess of the County's minimum parking requirements) may be constructed with permeable paving.	***X***		
	12.c.	Other design concepts that are comparable and equally effective.	***X***		
13.	**Fueling Area**				***X***
	Non-retail fuel dispensing areas shall contain the following.				
	13.a.	Overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area shall drain to the project's treatment control BMP(s) prior to discharging to the storm water conveyance system.			
	13.b.	Paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited.			
	13.c.	Have an appropriate slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of urban runoff.			
	13.d.	At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.			

Other project specific Source Control BMPs

No other project specific Source Control BMPs are being proposed at this time.

TREATMENT CONTROL

To select a structural treatment BMP using Treatment Control BMP Selection Matrix (Table 2), each priority project shall compare the list of pollutants for which the downstream receiving waters are impaired (if any), with the pollutants anticipated to be generated by the project (as identified in Table 1). Any pollutants identified by Table 1, which are also causing a Clean Water Act section 303(d) impairment of the receiving waters of the project, shall be considered primary pollutants of concern. Priority projects that are anticipated to generate a primary pollutant of concern shall select a single or combination of stormwater BMPs from Table 2, which **maximizes pollutant removal** for the particular primary pollutant(s) of concern.

Priority projects that are **not** anticipated to generate a pollutant for which the receiving water is Clean Water Act Section 303(d) impaired shall select a single or combination of stormwater BMPs from Table 2, which are effective for pollutant removal of the identified secondary pollutants of concern, consistent with the "maximum extent practicable" standard.

Table 2. Treatment Control BMP Selection Matrix

Pollutant of Concern	***Treatment Control BMP Categories***						
	Biofilters	Detention Basins	Infiltration Basins(2)	Wet Ponds or Wetlands	Drainage Inserts	Filtration	Hydrodynamic Separator Systems(3)
Sediment	M	H	H	H	L	H	M
Nutrients	L	M	M	M	L	M	L
Heavy Metals	M	M	M	H	L	H	L
Organic Compounds	U	U	U	M	L	M	L
Trash & Debris	L	H	U	H	M	H	M
Oxygen Demanding Substances	L	M	M	M	L	M	L
Bacteria	U	U	H	H	L	M	L
Oil & Grease	M	M	U	U	L	H	L
Pesticides	U	U	U	L	L	U	L

(1) Copermittees are encouraged to periodically assess the performance characteristics of many of these BMPs to update this table.
(2) Including trenches and porous pavement.
(3) Also known as hydrodynamic devices and baffle boxes.
L: Low removal efficiency
M: Medium removal efficiency
H: High removal efficiency
U: Unknown removal efficiency
Sources: *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), *National Stormwater Best Management Practices Database* (2001), *Guide for BMP Selection in Urban Developed Areas* (2001), *and Caltrans New Technology Report (2001).*

A Treatment BMP must address runoff from developed areas. The following table lists the water quality outfall(s) from the developed area(s). Post-construction water quality and 100 year peak flows are provided. The outfalls are identified on the BMP map in Attachment A. Q_{WQ} is used to size any flow based treatment BMPs utilized. Q_{100} is used to ensure that flow based BMPs can convey the peak flow.

Outfall*	Tributary Area (acres)	Q_{100} (cfs)	Q_{WQ} (cfs)
CP1	4.71	22.2	0.67
CP2	9.58	18.7	n/a

*The outfalls are listed as CP#. These are the confluence points as listed in project's drainage study titled 'Preliminary Drainage Study' by Wynn Engineering, Inc. dated March 5, 2008. This Preliminary Drainage Study is a separate document and is also part of San Diego County Project Number R04-17, Log Number 04-09-014. CP1 is at the outlet of the culvert/detention basin entrance. Then, once the runoff travels through the detention basin it will discharge at CP2, which is the ultimate discharge point at the western property boundary. There is no Q_{WO} for CP2 because the detention basin is a BMP a treatment control BMP that addresses the entire site discharge.

Please check the box(s) that best describes the Treatment BMP(s) selected for this project.

Biofilters
☒ Grass swale
☐ Grass strip
☐ Wetland vegetation swale
☐ Bioretention
Detention Basins
☒ Extended/dry detention basin with grass lining
☐ Extended/dry detention basin with impervious lining
Infiltration Basins
☐ Infiltration basin
☐ Infiltration trench
☐ Porous asphalt
☐ Porous concrete
☐ Porous modular concrete block
Wet Ponds or Wetlands
☐ Wet pond/basin (permanent pool)
☐ Constructed wetland
Drainage Inserts (do not use on County maintained right-of-way and easements)
☐ Oil/Water separator
☐ Catch basin insert
☐ Storm drain inserts
☐ Catch basin screens

Filtration
- ☐ Media filtration
- ☐ Sand filtration

Hydrodynamic Separator Systems
- ☐ Swirl Concentrator
- ☐ Cyclone Separator
- ☐ Baffle Separator
- ☐ Gross Solids Removal Device
- ☐ Linear Radial Device

Note: Catch basin inserts and storm drain inserts are excluded from use on County maintained right-of-way and easements.

Treatment Data in Attachment C. Any datasheets should include the following:	**COMPLETED**	**NO**
1. Description of how treatment BMP was designed. Provide a description for each type of treatment BMP.		
2. Engineering calculations for the BMP(s)		

The following is the Rationale for selecting the Treatment Control BMP(s) used on the project site:

Treatment Control BMP Selection – The selection of treatment control BMPs is based on the above in conjunction with information provided in Table 3 of the SUSMP, the "Treatment Control BMP Selection Matrix." Vegetated swales will be implemented to provide natural filtration. A detention basin will provide settling and mitigate the increased flows and velocities.

The BMPs to be incorporated are designed to mimic the predevelopment runoff characteristics. This is accomplished by a combination of treatment control BMPs. First, runoff from impervious surfaces flows to concave graded interior landscaping wherever possible. Regularly spaced openings in curbs around the landscape areas will disperse runoff throughout the landscape islands. These areas will be equipped with drain pipes to avoid ponding. The irrigation system for these landscaped areas will be monitored to prevent over irrigation. Runoff then flows to a vegetated swale at the southern margin of the parking lot. Flow then crosses School Bus Road via an existing 18" culvert and into an extended detention basin. The outlet of the detention basin flows to the preexisting natural channel and exits the property at the predevelopment discharge point.

continued below…

Vegetated Swales – Vegetated swales are vegetated channels that receive directed flow and convey storm water. An information sheet with schematic illustration is included in Attachment B and in LID Fact Sheet 4. In addition, LID Fact Sheet 17: Curb Cuts will be utilized to transport runoff to the vegetated swales. Pollutants are removed by filtration, sedimentation, adsorption to soil particles, and infiltration through the soil. Vegetated swales are mainly effective at removing debris and solid particles, although some dissolved constituents are removed by adsorption onto the soil. Vegetated Swales have two design goals: 1) maximize treatment, 2) provide adequate hydraulic function for flood routing, adequate drainage and scour prevention. Treatment is maximized by designing the flow of water through the swale to be as shallow and long as site constraints allow.

Detention Basins – Detention ponds are basins whose outlets have been designed to detain the stormwater runoff from a design storm. This allows particles and associated pollutants to settle. There is no permanent pool of water associated with a detention pond. They also provide attenuation of elevated flows and velocities from developed areas. LID Fact Sheet 3 provides information on an Extended Detention (dry) pond. The detention basin must be sized to maintain flows to predevelopment levels and provide detention time to allow settling action to treat the water. The volume of water and depth must be taken into consideration so as to avoid the creation of a jurisdictional dam. In this case the amount of flow can be handled by a non-jurisdictional size dam.

This section intentionally left blank

MAINTENANCE

Please check the box that best describes the maintenance mechanism(s) for this project.

CATEGORY	SELECTED	
	YES	NO
First	X	
Second	X	
Third		
Fourth		

The following is a brief description of long-term fiscal resources for maintenance of the selected Treatment Control BMPs:

Since this is a discretionary project that requires a use permit, it is proposed that appropriate terms, agreeable to the County, be included in the use permit to provide sufficient assurance of maintenance of storm water BMPs. The County may condition acceptance of this mechanism on a backup agreement with the developer to ultimately be accountable to the County to pay all costs for BMP maintenance, repair or replacement if a subsequent owner fails to perform. It is assumed that a Category 2 BMP Maintenance Agreement will be a condition for the project and will be used as the maintenance mechanism of choice by the County of San Diego. At this time it is proposed that the developer will provide the County with security to substantiate the maintenance agreement, which would remain in place for an interim period of 5 years. The amount of the security would equal the estimated cost of 2 years of maintenance activities. The security can be a Cash Deposit, Letter of Credit or other form acceptable to the County. The amount of the security is estimated to be approximately $14,600 per the San Diego County SUSMP Appendix H.

CONCLUSION

The combination of proposed construction and post-construction BMPs will reduce, to the maximum extent practicable, the expected pollutants and will not adversely impact the beneficial uses or water quality of the receiving waters.

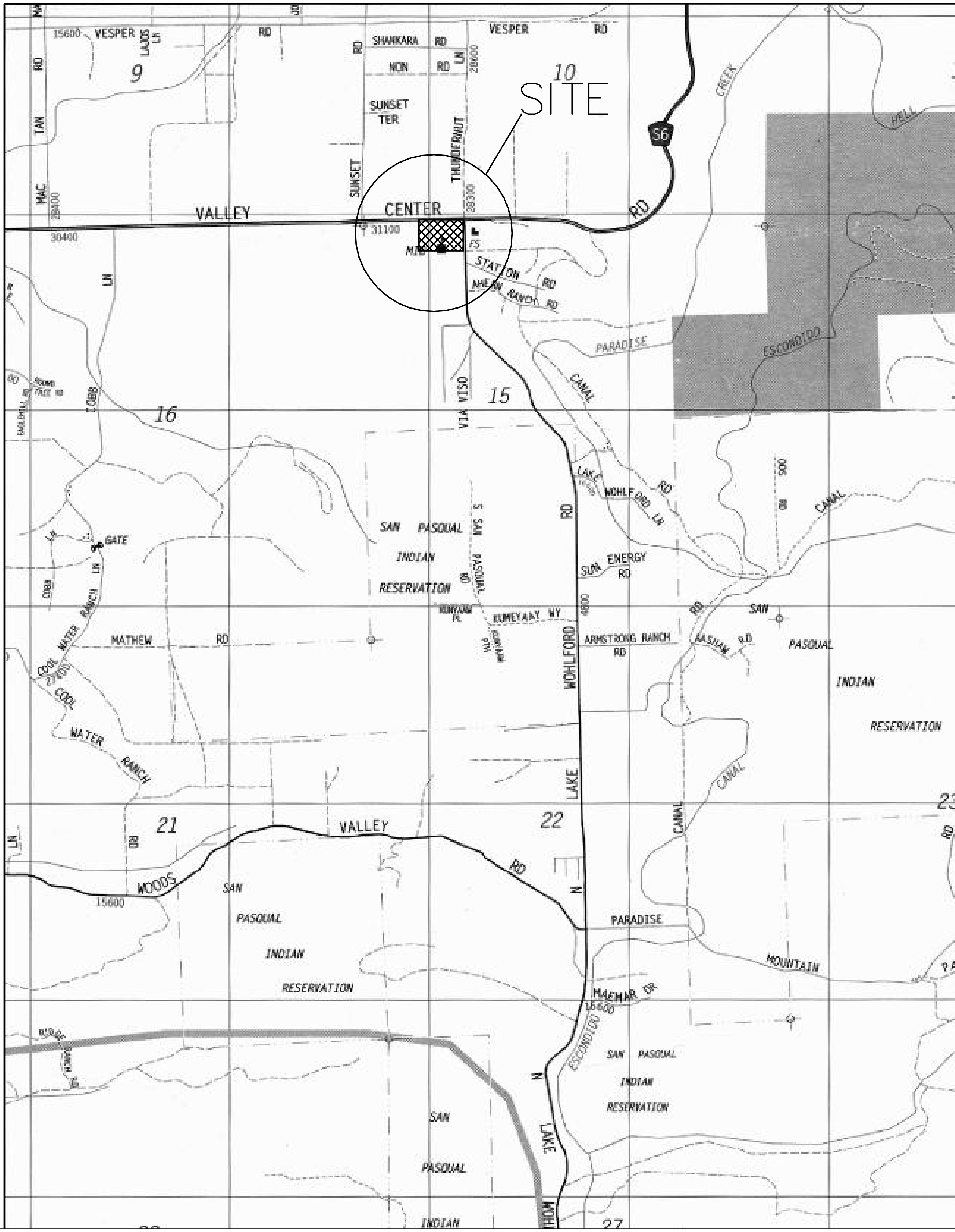
ATTACHMENTS

The following attachments are included:

ATTACHMENT		COMPLETED	N/A
A	Project Location/Site/Treatment BMP Location Map	*X*	
B	Relevant Monitoring Data	*X*	
C	Treatment BMP Data	*X*	
D	Operation and Maintenance Program	*X*	
E	Engineer's Certification Sheet	*X*	

ATTACHMENT A

PROJECT LOCATION/SITE/BMP MAP

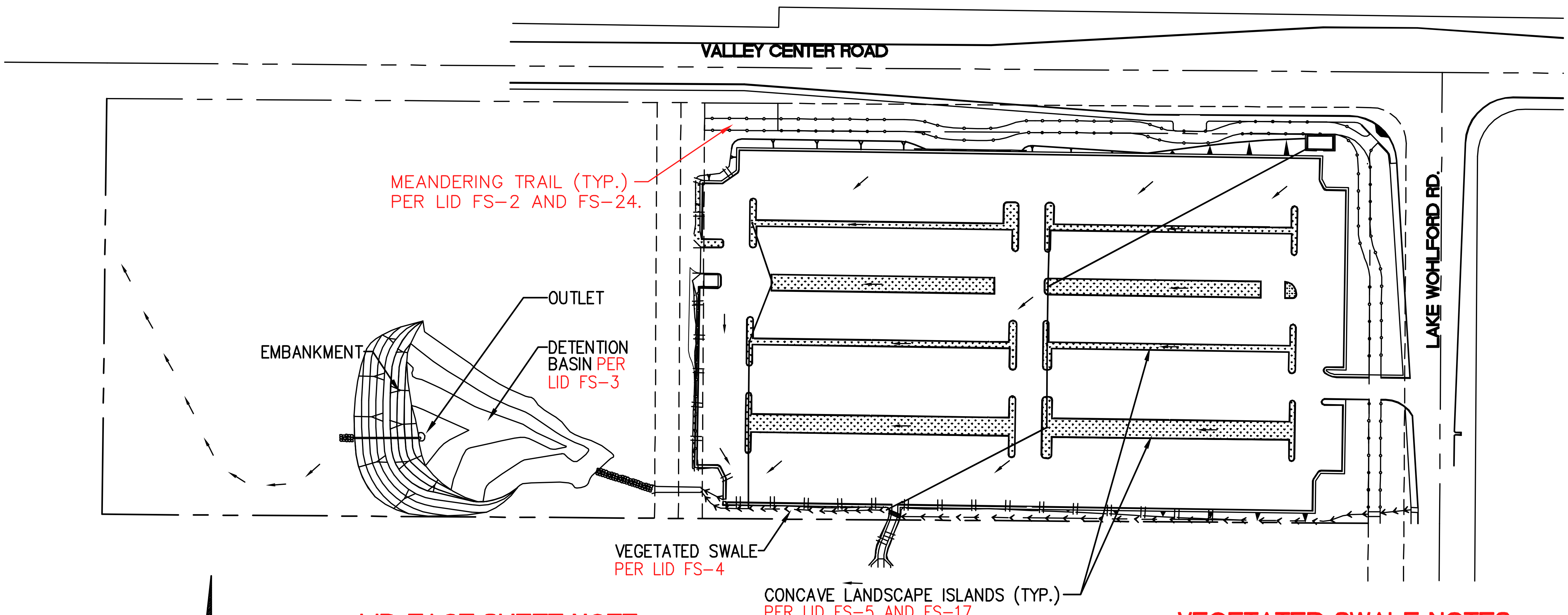


San Pasqual Casino Development Group
Remote Parking Area Project
Preliminary Drainage Study

VICINITY MAP

No Scale

BMP MAP

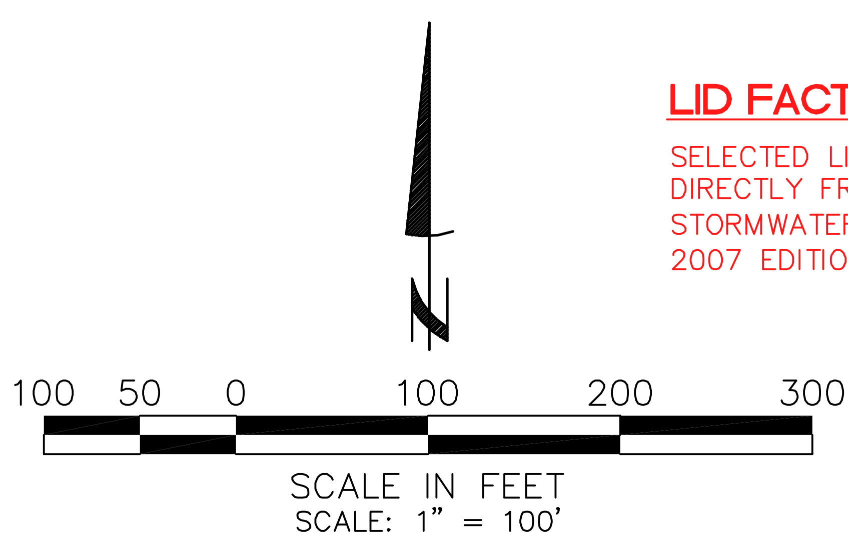


LID FACT SHEET NOTE:

SELECTED LID FACT SHEETS ARE TAKEN DIRECTLY FROM THE COUNTY OF SAN DIEGO LID STORMWATER STRATEGIES MANUAL (DRAFT 2007 EDITION).

VEGETATED SWALE NOTES:

1. VEGETATED SWALE TO BE A MINIMUM 100 FOOT LENGTH.
2. MAXIMUM ALLOWABLE LONGITUDINAL SLOPE IS 2.5%



REGISTERED PROFESSIONAL ENGINEER
GARY R. WYNN
No. C 43202
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COSD# R04-017, LOG# 04-09-014, SPCDG 05-060

ATTACHMENT B

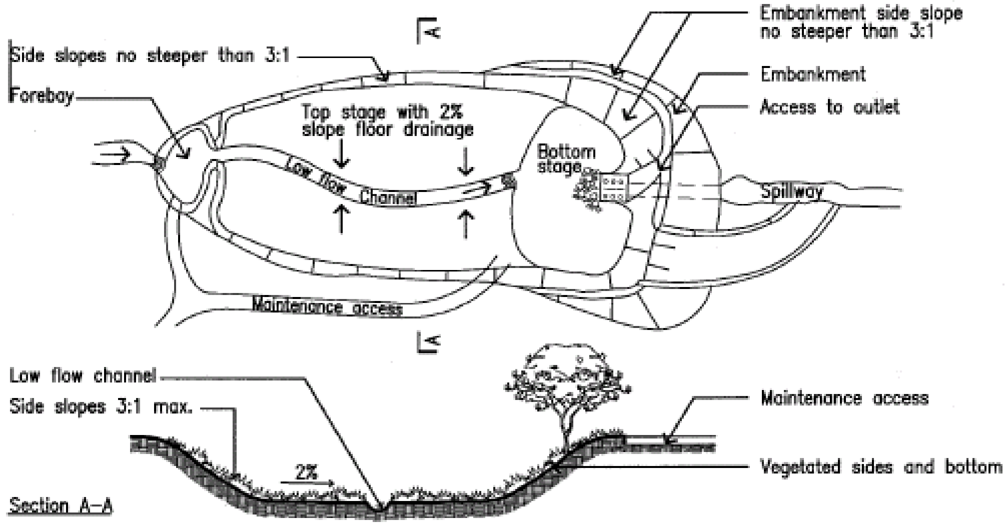
RELEVANT MONITORING DATA

(NO RELEVANT WATER QUALITY MONITORING DATA AVAILABLE.)

ATTACHMENT C

TREATMENT BMP DATA

Fact Sheet 3. Extended detention (dry) ponds



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Extended detention (dry) ponds store water during storms for a short period of time (from a few hours up to a few days), and discharge water to adjacent surface waters. Stormwater design volumes are designed to be stored in such basins for more than 1 day to provide adequate settling time and maximize pollutant removal. The basins are dry between storms, and do not have a permanent pool of water. This tool is best suited for use as part of a treatment train in conjunction with other LID techniques.

CHARACTERISTICS

- If properly designed, ponds can have a lifetime of 50 years.
- Clay or impervious soils should not affect pollutant removal effectiveness, as the main removal mechanism is settling.
- Pollutants removed primarily through gravitational settling of suspended solids, though a small portion of the dissolved pollutant load may be removed by contact with the pond bottom sediments and/or vegetation, and through infiltration.
- Moderate removal of suspended solids (sediment) and heavy metals.
- Low to moderate removal of nutrients and Biological Oxygen Demand (B.O.D.).
- Pollutant removal can be maximized by increasing residence time (average 24 hours); two-stage pond design, with the addition of wetland vegetation to lower stages of the pond; sediment trapping forebay to allow efficient maintenance; regular maintenance and sediment cleanout; installing adjustable gate valves to achieve target detention times; designing pond outlet to detain smaller treatment volumes (less than two-year storm event).

APPLICATION

- May be initially used as construction settling basins, but must be regraded and cleaned out before used as a post-construction pond.
- May be designed for both pollutant removal and flood control.
- May be appropriate for developments of 10 acres or larger.

- Potential for multiple uses including flood control basins; parks, playing fields, and tennis courts; open space; overflow parking lots.

DESIGN

- Coordinate pond design, location, and use with local municipal public works department and/or county flood control department to reduce potential downstream flooding.
- Default conditions for safety have been to fence basins with chain link. Consider aesthetic design elements with safety analyst to address pond barriers, such as fencing and/or vegetation, and shallow side slopes (8:1 to 12:1).
- See County of San Diego Drainage Design Manual section 6.1

MAINTENANCE

- Regular inspection during wet season for sediment buildup and clogging of inlets and outlets (designing a forebay to trap sediment can decrease frequency of required maintenance, as maintenance efforts are concentrated towards a smaller area of the basin and less disruptive than complete basin cleaning).
- Clean inlet trash rack and outlet standpipe as necessary.
- Clean out basin sediment approximately once per year (this may vary depending on pond depth and design, and if forebay is used).
- Mow and maintain pond vegetation, replant or reseed as necessary to control erosion.

LIMITATIONS

- Limitation of available space.
- Dry detention ponds have only moderate pollutant removal when compared to some other structural treatment controls and are relatively ineffective at removing soluble pollutants.
- Basins must be designed with vector control, sediment and vegetation removal/maintenance considerations in mind.

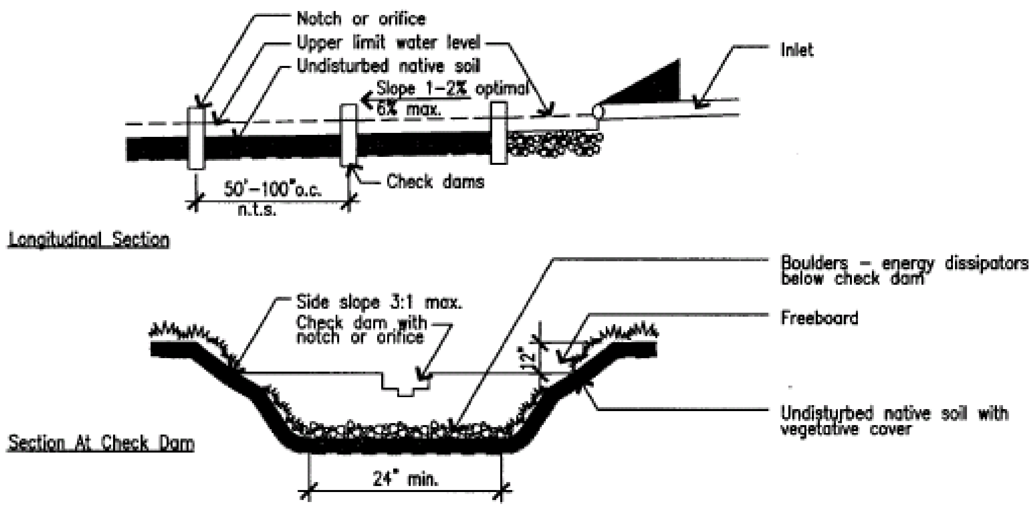
ECONOMICS

- Least expensive stormwater quality pond option available. 0-25% additional cost when added to conventional stormwater detention facilities.
- Construction cost $0.10-$5.00 per cubic foot of storage (savings from preparing silt basins used during construction for use as extended detention ponds).
- Maintenance cost 3-5% of construction cost annually.

REFERENCES

- California Stormwater Quality Association. (2003, January) California Stormwater BMP Handbook: New Development and Redevelopment.
- For additional information pertaining to extended detention ponds, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 4. Vegetated Swale / Rock Swale



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

Vegetated / rock swales are vegetated or rock lined earthen channels that collect, convey, and filter site water runoff and remove pollutants. Swales are an alternative to lined channels and pipes; configuration and setting are unique to each site.

CHARACTERISTICS

- If properly designed and maintained, swales can last for at least 50 years.
- Can be used in all types of soil.
- When swales are not holding water, they appear as a typical landscaped area.
- Water is filtered by vegetation/rocks and pollutants are removed by infiltration into the subsurface of the soil.
- Swales also serve to delay runoff peaks by reducing flow velocities.

APPLICATION

- Swales are most effective in removing coarse to medium sized sediments.
- Parking lot medians, perimeters of impervious pavements.
- Street and highway medians, edges (in lieu of curb and gutter, where appropriate).
- In combination with constructed treatment systems or sand filters.

DESIGN

- Grass swales move water more quickly than vegetated swales. A grass swale is planted with salt grass; a vegetated swale is planted with bunch grass, shrubs or trees.
- Vegetation of each swale is unique to the setting, function, climate, geology, and character of each site and climatic condition.
- Rocks, gravel, boulders, and/or cobbles help slow peak velocity, allow sedimentation, and add aesthetic value.
- Pollutant removal effectiveness can be maximized by increasing residence time of water in swale.

- Swales are often used as an alternative to curbs and gutters along roadways, but can also be used to convey stormwater flows in recreation areas and parking lots.
- Calculations should also be provided proving the swale capable of safely conveying the 100-year flow to the swale without flooding adjacent property or infrastructure.
- See County of San Diego Drainage Design Manual for design criteria. (section 5.5) http://www.sdcounty.ca.gov/dpw/docs/hydrologymanual.pdf

MAINTENANCE

- Swale maintenance includes mowing and removing clippings and litter. Vegetated swales may require additional maintenance of plants.
- Periodically remove sediment accumulation at top of bank, in swale bed, or behind check dams.
- Monitor for erosion and reseed grass or replace plants, erosion control netting and mulch as necessary. Fertilize and replace vegetation well in advance of rainy season to minimize water quality degradation.
- Regular inspections and maintenance is required during the establishment period

LIMITATIONS

- Only suitable for grades between 1% and 6%
- Turf swales will commonly require irrigation and may not meet State water conservation goals.
- Irrigated vegetation is not appropriate in certain sites. Xeriscape techniques, natural stone and rock linings can be used as an alternative to turf.
- Site requires adequate sunlight for vegetation growth
- Pre-treatment of gross pollutants at the construction site may be required
- Wider road corridors may be required to incorporate swales
- Contributing drainage areas should be limited to 5 acres or less
- When contributing flow could cause formation of low-flow channel, channel dividers must be constructed to direct flow and prevent erosion.

ECONOMICS

- Estimated grass swale construction cost per linear foot $4.50-$8.50 (from seed) to $15-20 (from sod), compare to $2 per inch of diameter underground pipe e.g., a 12” pipe would cost $24 per linear foot).
- $0.75 annual maintenance cost per linear foot

REFERENCES

- CALTRANS – Storm Water Handbook (cabmphandbooks.com)
- 3150 Porter Drive, Palo Alto, CA. Parking lot and roof runoff drains to swale at office building.
- 5750 Almaden Blvd., San José, CA. Santa Clara Valley Water District offices.
- For additional information pertaining to Swales, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 5. Vegetated Filter Strips

A filter strip (or "buffer strip") is an area of either planted or native vegetation, situated between a potential, pollutant-source area and a surface-water body that receives runoff. Vegetated filter strips are broad sloped open vegetated areas that accept shallow runoff from surrounding areas as distributed sheet flow.

CHARACTERISICS

- Can serve to remove sediments by filtration through the vegetation, reducing runoff volumes, and delaying runoff peaks by reducing flow velocities.
- A properly designed and operating filter strip provides water-quality protection by reducing the amount of sediment, organic matter, nutrients and pesticides in the runoff at the edge of the field, and before the runoff enters the surface-water body.
- Filter strips also provide localized erosion protection since the vegetation covers an area of soil that otherwise might have a high erosion potential.
- Often constructed along stream, lake, pond or sinkhole boundaries, filter strips installed on cropland not only help remove pollutants from runoff, but also serve as habitat for wildlife.

APPLICATION

- Most effective in removing coarse to medium sediments and attached pollutants (such as nutrients, free oils/grease and metals).
- Typically used in conjunction with swales as an alternative to curb and gutter and can form part of a multi-use corridor.
- Typically used as a pre-treatment for other stormwater treatment devices (treatment train).

DESIGN

- The proper application of a filter strip should consider the type and quantity of the potential pollutant (sediment, nutrient, pesticide, organic matter, etc.), soil characteristics (clay and organic matter content, infiltration rate, permeability, etc.), slope steepness, shape and area of the field draining into the filter.
- Most effective when used on relatively flat areas with a slope less than or equal to 5%
- The type of vegetation most suitable for the site should be decided based on soil type, potential pollutant sources/types, infiltration needs, etc.
- Once the type of vegetation is selected, soil fertility should be evaluated, and the seeding method selected.

MAINTENANCE

- Filter strips must be inspected frequently, especially after intense rainfall events and runoff events of long duration because small breaks in the sod and small erosion channels quickly become large problems.

- Minimize the development of erosion channels within the filter. Even small channels may allow much of the runoff from the field to bypass the filter. These areas should be repaired and reseeded immediately to help ensure proper flow of runoff through the filter.
- Periodic soil testing should occur and soil amendments should be applied as needed.
- Weeding may be necessary to reduce or eliminate weeds that could compromise the filter strip's effectiveness.

LIMITATIONS

- Suitable only for relatively flat or gradually sloping areas.
- Turf buffer strips will commonly require irrigation and may not meet State water conservation goals.
- Irrigated vegetation may not be appropriate in certain sites. Xeriscape techniques, natural stone and rock linings can be used as an alternative to turf.
- Requires adequate sunlight for plant growth
- Effectiveness is dependant on soil characteristics, slope steepness, landscape shape, the ratio of the filter area to the area generating the runoff, filter width, and the type and quality of the vegetation in the filter.
- Regular inspections and maintenance is required, particularly during the establishment period.
- Suitable only for small contributing drainage areas (less than 1 acre)

ECONOMICS

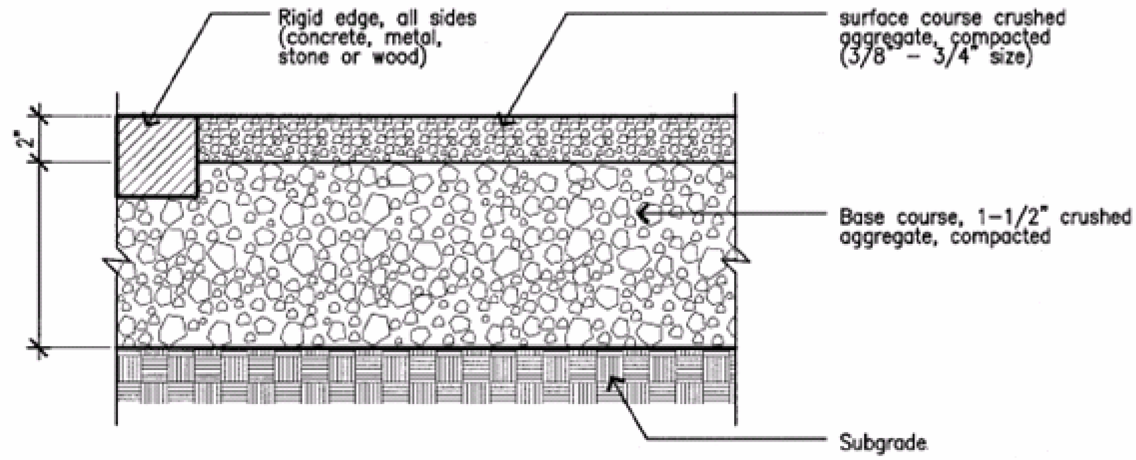
- Installation costs for filter strips may be estimated by considering the amount of grading, seeding, and establishment required for the site. Filter strip installation costs are similar to those of vegetative swales, and typically lower than costs for bioretention swales with soil amendment or sand media filtration devices (2003 CASQA Development Handbook Tables 5-4 and 5-5).

REFERENCES

- California Stormwater Quality Association. (2003, January) California Stormwater BMP Handbook: New Development and Redevelopment.
- Leeds, R., Brown, L. C., Sulc, M. R., VanLieshout, L, (n. d.) Vegetated Filter Strips: Application, Installation, and Maintenance. *Food, Agriculture and Biological Engineering*. Ohio State University Extension. http://ohioline.osu.edu/aex-fact/0467.html0
- URS Australia Pty Ltd, (2004, May), Water Sensitive Urban Design: Technical Guidelines for Western Sydney, Upper Parramatta River Catchment Trust. Section 3.
- Southeastern Wisconsin Regional Planning Commission (1991). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

- For additional information pertaining to Filter Strips, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 12. Crushed Aggregate (gravel)



A variety of crushed aggregates, generally known as gravel, can be used to form a permeable pavement. Found in a variety of settings ranging from Parisian cafes to Japanese ceremonial gardens to rural roadways, crushed aggregate is a versatile, economical permeable pavement material with a long history of use.

CHARACTERISTICS

- A granular material, crushed aggregate can be laid in any shape field or configuration.
- Runoff coefficient: 0.10 – 0.40". Pavements of fine crushed stone (e.g. decomposed granite fines) are relatively impermeable. Permeability increases with larger aggregate sizes. Open-graded mixes are more permeable than mixes that include fines.
- Easy to install.
- Reduces impervious land coverage.

APPLICATION

- Low volume and low speed vehicle traffic areas.
- Parking stalls, private driveways, walkways, and patios.
- Areas of low erosion.
- Not appropriate for ADA-compliant accessible paths of travel.
- Flat sites (slope < 5%) with uniform, permeable subgrade.

DESIGN

- Because the aggregate is laid loose, the field must be enclosed by a rigid frame in most applications. Concrete, mortared brick on a concrete grade beam, redwood header, and metal edging are commonly used.
- To maximize permeability, use an open-graded crushed rock base course (not rounded pea gravels or fines).
- In areas with pedestrian traffic, use smaller aggregate (3/8" size). Larger aggregate (3/4" size) makes a better driving surface.

MAINTENANCE

- Longevity ensured by locating in low erosion conditions, quality construction, and installation of good base layer.
- Easy to repair since aggregate is easily regraded and replenished.
- Occasional weed suppression may be required.
- To maximize permeability, minimize compaction of subgrade.
- Periodic and/or replenishing, raking of displaced gravel may be required.

LIMITATIONS

- Dust Control
- Not appropriate for ADA-compliant accessible paths of travel.
- Because the aggregate is laid loose, the field must be enclosed by a rigid frame in most applications.
- Avoid using permeable pavements in close proximity to underground utilities. If it is necessary to use permeable pavements in these areas, care must be taken to keep infiltrated water form migrating into utility trench bedding.

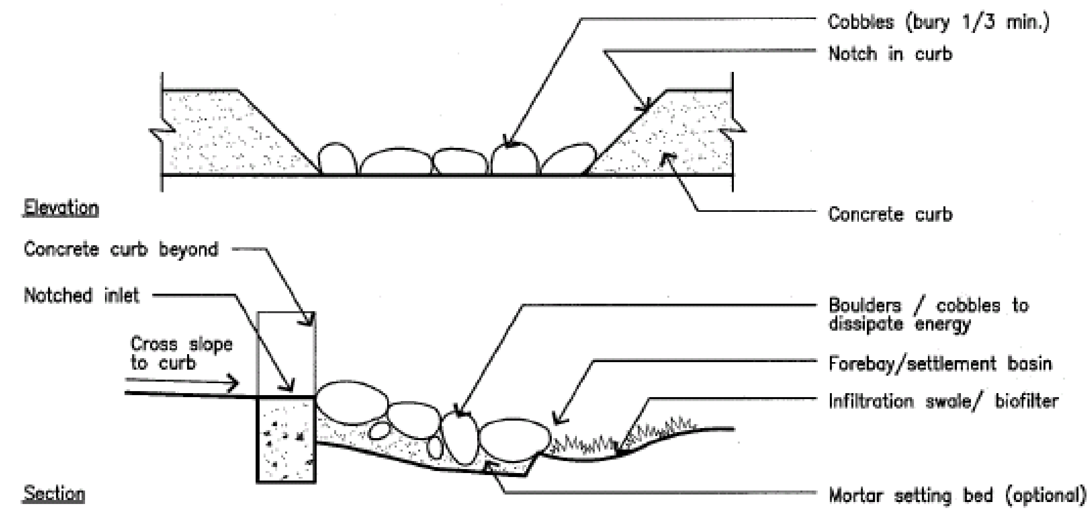
ECONOMICS

- Less expensive than conventional asphalt or concrete pavement.
- Least expensive of all pavements, ranging from $1 to $3 per square foot.
- Reduced impervious land coverage reduces or eliminates need for catch basins/ underground storm drain system.

REFERENCES

- Ferguson, Bruce K. (2005). Porous Pavements: Integrative studies in water management and land development. CRC Press, Boca Raton, Florida.
- For additional information pertaining to Crushed Aggregate, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 17. Curb-cuts



Conditions, dimensions, and materials shown are typical. Modifications may be required for proper application, consult qualified professional.

On streets where a more urban character is desired or where a rigid pavement edge is required, curb and gutter systems can be designed to empty into drainage swales. These swales can run parallel to the street, in the parkway between the curb and the sidewalk, or can intersect the street at cross angles, and run between residences, depending on topography. Runoff travels along the gutter, but instead of being emptied into a catch basin and underground pipe, multiple openings in the curb direct runoff into surface swales or infiltration/detention basins. If lined with ground cover or gravel/rock and gently sloped, these swales function as biofilters. Because concentration of flow will be highest at the curb opening, erosion control must be provided, which may include a settlement basin for ease of debris removal.

Urban curb/swale systems are a hybrid of standard urban curb and gutter with a more rural or suburban swale drainage system. It provides a rigid pavement edge for vehicle control, street sweeping, and pavement protection, while still allowing surface flow in landscaped areas for stormwater quality protection.

CHARACTERISTICS

- Runoff travels along the gutter, but instead of being emptied directly into catch basins and underground pipes, it flows into surface swales.
- Stormwater can be directed into swales either through conventional catch basins with outfall to the swale or notches in the curb with flow line leading to the swale.
- Swales remove dissolved pollutants, suspended solids (including heavy metals, nutrients), oil and grease by infiltration.

APPLICATION

- Can be created in existing and new residential developments, commercial office parks, arterial streets, concave median islands.

- Swale system can run either parallel to roadway or perpendicular to it, depending on topography and adjacent land uses.

DESIGN

- Size curb-openings or catch basins for design storm.
- Multiple curb openings closely spaced are better than fewer openings widely spaced because it allows for greater dissipation of flow and pollutants.
- Provide energy dissipaters at curb notches or catch basin outfall into swale.
- Provide settlement basin at bottom of energy dissipater to allow for sedimentation before water enters swale.
- Curb cuts should be at least 12 inches wide to prevent clogging.

MAINTENANCE

- Annual removal of built-up sediment in settlement basin may be required.
- Catch basins require periodic cleaning.
- Inspect system prior to rainy season and during or after large storms.

LIMITATIONS

- Parking requirements and codes

ECONOMICS

- Cobble-lined curb opening may add marginal cost compared to standard catch basin.
- Swale system requires periodic landscape maintenance.

REFERENCES

- Village Homes subdivision, Davis, CA. Residential street network,
- Folsom, CA. Dual-drainage system,
- For additional information pertaining to Curb-cuts, see the works cited in the San Diego County LID Literature Index.

Fact Sheet 24. LID Driveway, Sidewalk, and Bike Path Design

CHARACTERISTICS
Driveways, sidewalks and bike paths are another source of impervious coverage that can adversely affect water quality by the runoff generated from their surface. Several management opportunities and strategies are available to reduce this impact, including:

- Reducing sidewalks to one side of the street.
- Utilize shared driveways to provide access to several homes.
- Disconnect bike paths from streets. Bike paths separated from roadways by vegetated strips reduce runoff and traffic hazards.
- Utilizing pervious materials to infiltrate or increase time of concentration of storm flows.
- Reducing driveway and sidewalk width when possible.
- Directing driveway and sidewalk runoff to adjacent vegetation to capture, infiltrate, and treat runoff.
- Installing a bioretention area or swale between the street and sidewalk and grading runoff from the sidewalk to these areas.
- Planting trees between the sidewalk and streets to capture and infiltrate runoff.
- Installing grated infiltration systems in sidewalks and bike paths to receive runoff as sheet flow. These can be installed to protect trees or can provide off-line stormwater management via a grate over an infiltration trench.

APPLICATION
- Residential Subdivisions, single family and multi-family homes.
- Commercial Development
- Public Parks

DESIGN
- Grade driveways, sidewalks, and bike paths at a two percent slope to direct runoff to an adjacent vegetated area.
- Pervious materials such as permeable pavers, permeable concrete or asphalt, gravel, or mulch can be utilized for sidewalk surfaces.
- In some cases, sidewalks and bike paths can be placed between rows of homes to increase access and decrease overall effective imperviousness.
- Grated infiltration systems should include removable grates to allow for maintenance, and must be capable of bearing the weight of pedestrians.

LIMITATIONS
- Ordinances may require sidewalks on both sides of the street.
- Groundwater table must not be within 10 feet of the bottom of infiltration trenches.

MAINTENANCE CONSIDERATIONS

- Maintenance necessary is related to the techniques applied (permeable materials, bioretention, swales).
- Vector breeding may occur in bioretention and swales if not properly designed or maintained.

ECONOMICS

- Costs are related to the number, type and size of the techniques applied.

REFERENCES

- For additional information pertaining to LID Driveway, Sidewalk, and Bike Path Design see the works cited in the San Diego County LID Literature Index.

Extended Detention Basin TC-22

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).

- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.

- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.

- Outlet designed to discharge the capture volume over a period of hours.

- Length to width ratio of at least 1.5:1 where feasible.

- Basin depths optimally range from 2 to 5 feet.

- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.

- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.

- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.

- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2g(H-H_o))^{0.5}$$

where:
- Q = discharge (ft^3/s)
- C = orifice coefficient
- A = area of the orifice (ft^2)
- g = gravitational constant (32.2)
- H = water surface elevation (ft)
- H_o = orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and re-grade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

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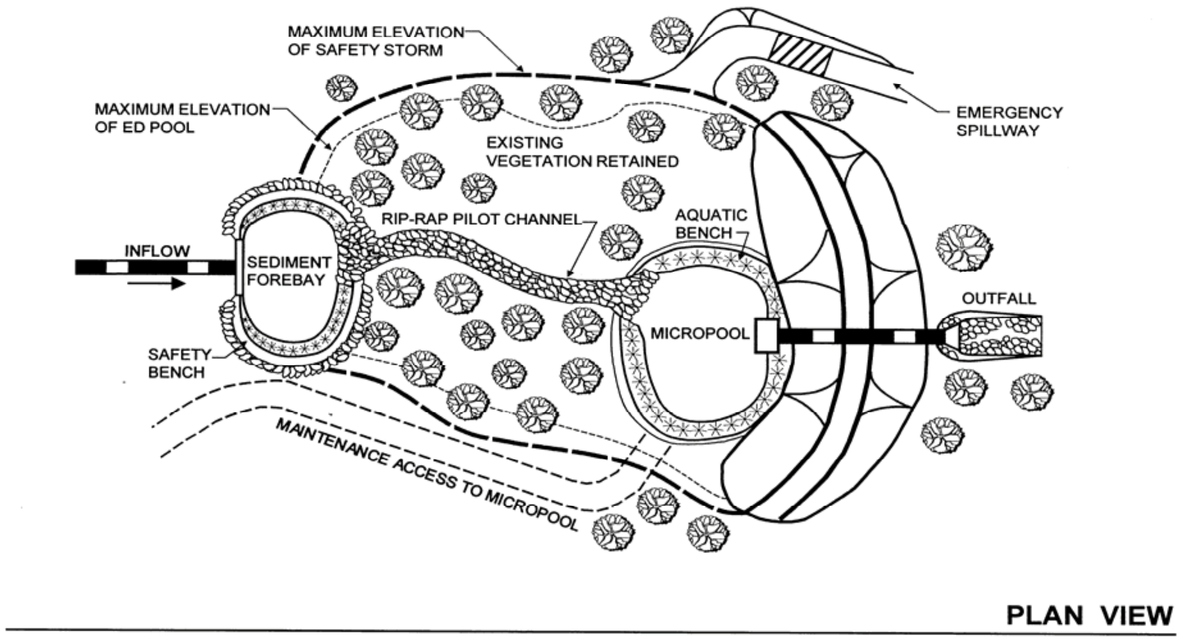

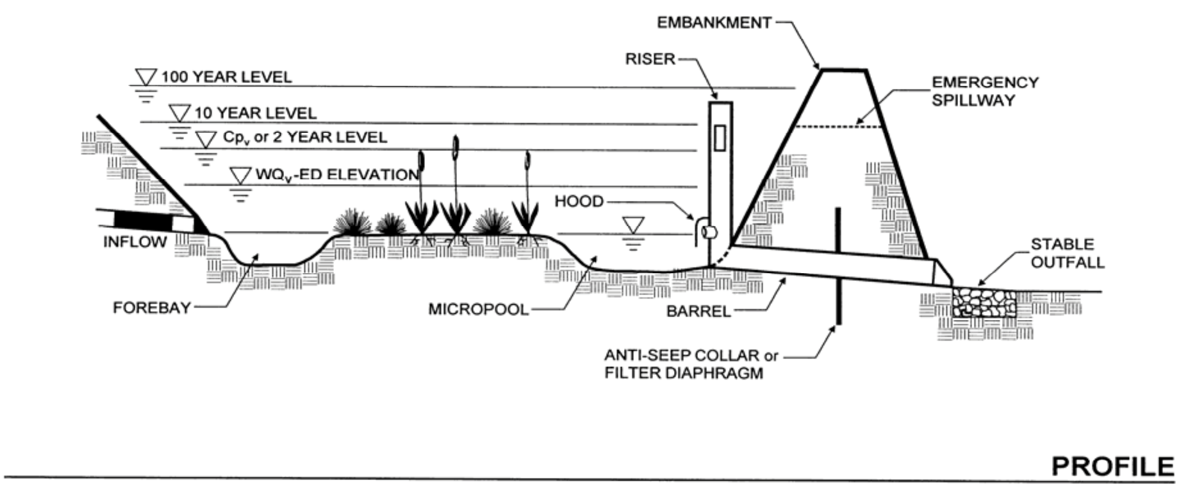

Schematic of an Extended Detention Basin (MDE, 2000)

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

✓	Sediment	▲
✓	Nutrients	●
✓	Trash	●
✓	Metals	▲
✓	Bacteria	●
✓	Oil and Grease	▲
✓	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

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- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.

- May not be appropriate for industrial sites or locations where spills may occur

- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.

- A thick vegetative cover is needed for these practices to function properly.

- They are impractical in areas with steep topography.

- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.

- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.

- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.

- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.

- Longitudinal slopes should not exceed 2.5%

- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.

- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.

- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.

- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data

Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
	Removal Efficiencies (% Removal)						
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.

- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.

- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.

- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately \$0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately \$0.50 per ft^2, which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]...............	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c].............	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]...........	Yd³	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]........	Yd²	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]..	Yd²	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]......................	Yd²	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	–	--	–	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	–	--	–	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right)$ x swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft^2/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft^2/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd^2	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	**$0.58 / linear foot**	**$ 0.75 / linear foot**	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

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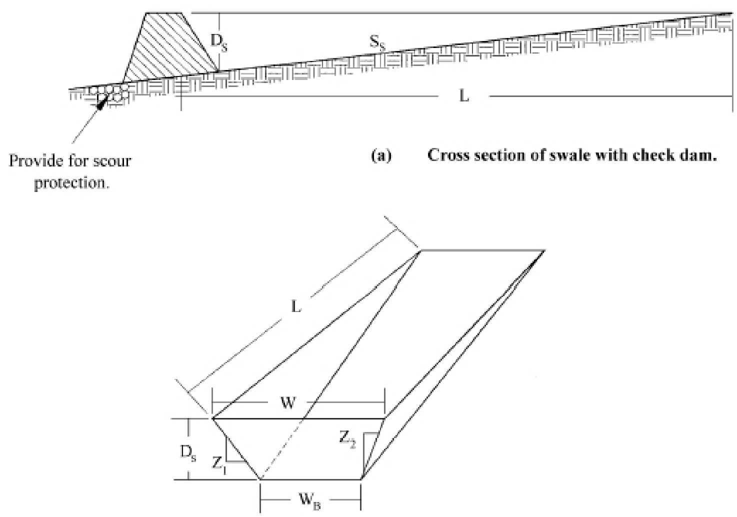


(a) Cross section of swale with check dam.

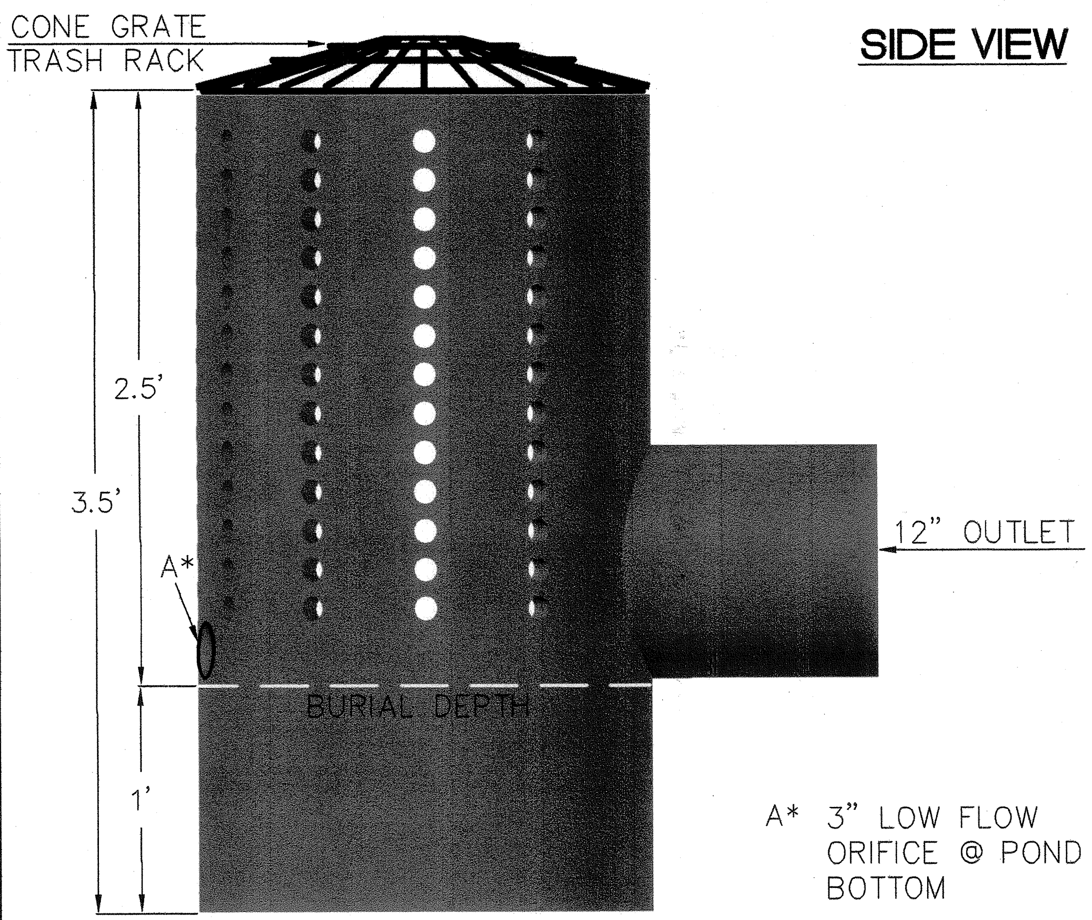
(b) Dimensional view of swale impoundment area.

Notation:

L = Length of swale impoundment area per check dam (ft)
D_S = Depth of check dam (ft)
S_S = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

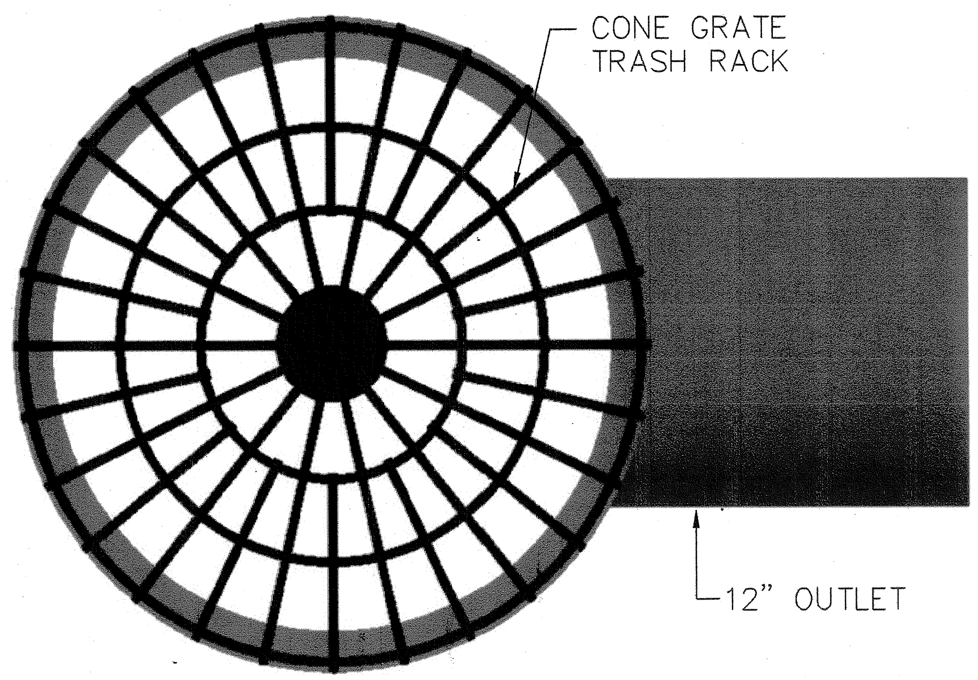
OUTLET STRUCTURE

SIDE VIEW



A* 3" LOW FLOW ORIFICE @ POND BOTTOM

TOP VIEW



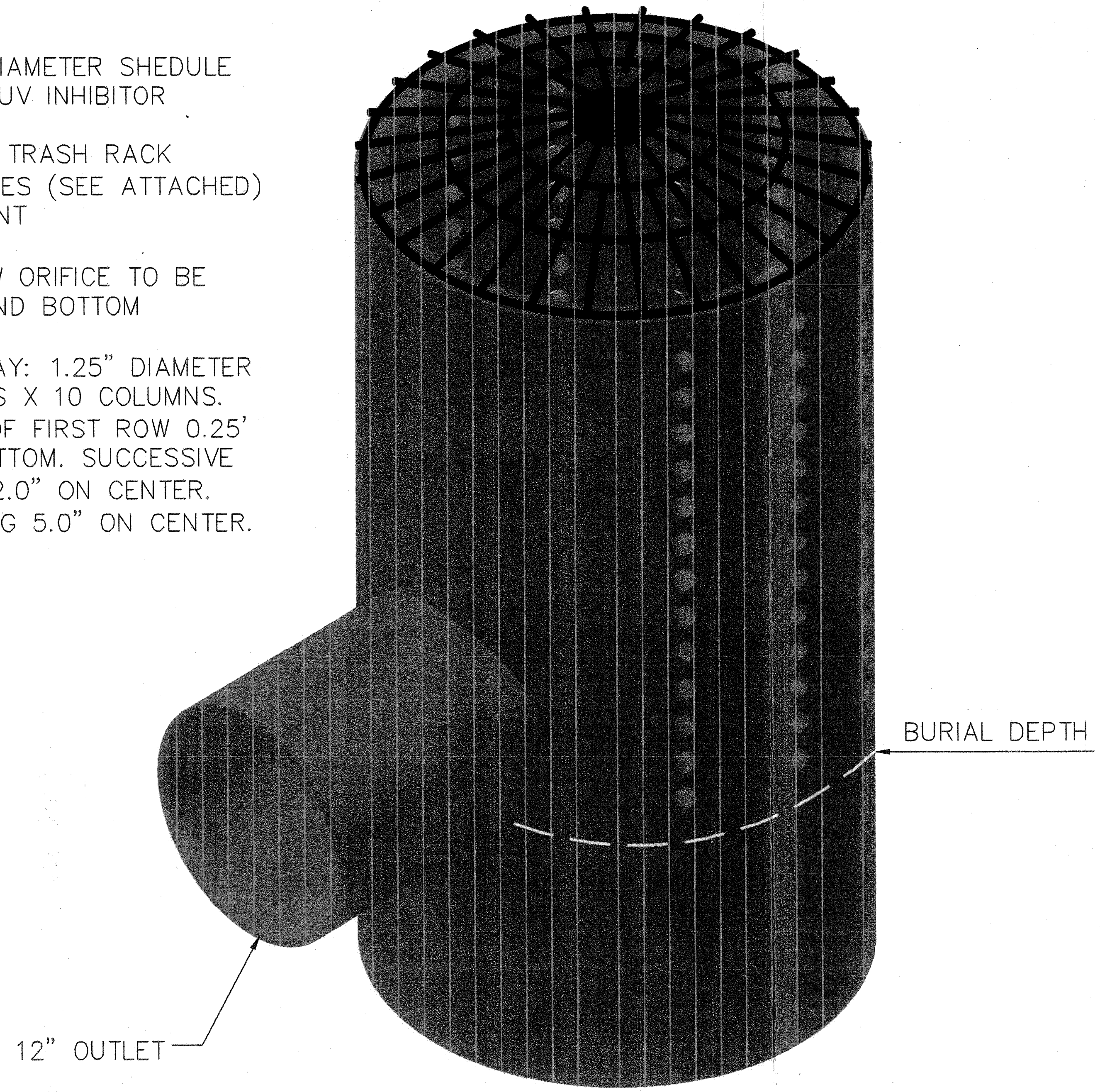
SPECIFICTIONS

1. RISER: 24" DIAMETER SHEDULE 40 P.V.C. WITH UV INHIBITOR

2. CONE GRATE TRASH RACK HAALA INDUSTRIES (SEE ATTACHED) – OR EQUIVALENT

3. 3" LOW FLOW ORIFICE TO BE FLUSH WITH POND BOTTOM

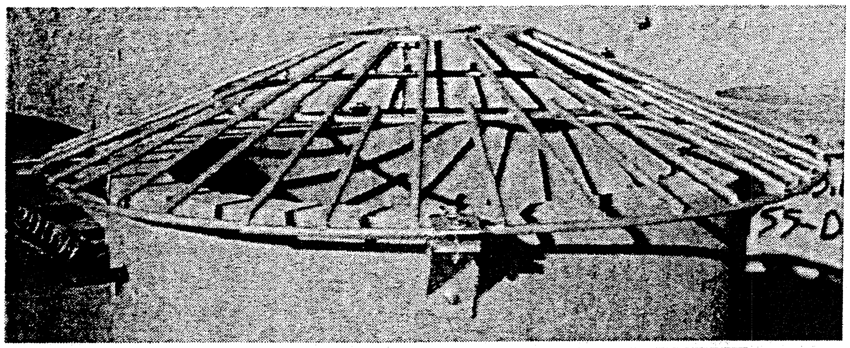
4. ORIFICE ARRAY: 1.25" DIAMETER HOLES, 13 ROWS X 10 COLUMNS. BOTTOM EDGE OF FIRST ROW 0.25' FROM POND BOTTOM. SUCCESSIVE ROWS SPACED 2.0" ON CENTER. COLUMN SPACING 5.0" ON CENTER.



ISOMETRIC VIEW

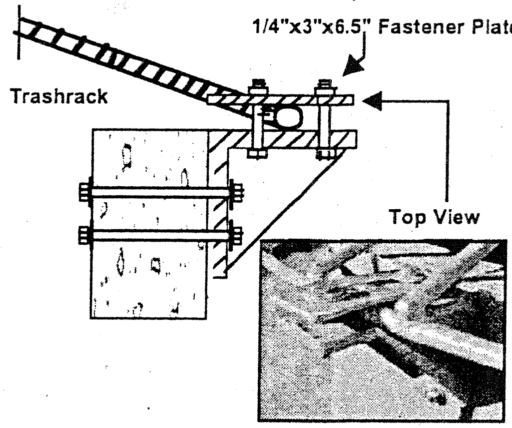
HAALA INDUSTRIES
SLEEPY EYE, MN
507-794-5821
www.haala.com

Cone Grate Trashrack
with Angle Brkt. & Fastener Plate
(Side Mount Style)



Mount Angle Brkt Flush with top of pipe.

Fastener Detail
(with Fastener Plate)



TRASHRACK DIMENSION TABLE **2007 PRICES - Galvanized**

Pipe Dia.	Bar Dia.	Wall Thickness	# of Brkts	Price 1-10	Price 11-24	Price 25+
24"	3/4"		4			
27"	3/4"	3-1/4"	4			
30"	3/4"		4			
36"	3/4"	4"	4			
48"	3/4"	5"	4			
54"	3/4"	5-1/2"	4			
60"	3/4"	6"	6			
66"	3/4"	6-1/2"	6			
72"	3/4"	7"	8			
84"	3/4"	8"	8			
96"	3/4"	9"	8			
108"		10-3/4"	8			
120"	1"	11-3/4"	8			

07-44

ATTACHMENT D

OPERATION AND MAINTENANCE

ATTACHMENT D: OPERATIONS AND MAINTENANCE PLAN

Operations & Maintenance of BMPs is essential for the success of any SUSMP. In order to perform proper O&M the project will be required to maintain and inspect their Post Construction BMPs for the life of the project. An inspection schedule and maintenance directions must be prepared for each Post Construction BMP that is install on the project site.

INSTALLED POST CONSTRUCTION BMP DEVICES

The project utilizes vegetated swales per County of San Diego LID Fact Sheet 4: Vegetated Swales and Rock Swales and an extended detention (dry) basin per County of San Diego LID Fact Sheet 3: Extended Detention (Dry) Basin.

INSPECTION FORM

The project may use the attached form to keep a record of inspection and maintenance activities. The County of San Diego will have the required length of time that records must be kept, but keep in mind that the County of San Diego or the Regional Water Quality Control Board can ask for inspection and maintenance records for up to five years from the time that they occur. The attached form is general and blank and is intended to be copied for use.

VEGETATED SWALES

The following is inspection and maintenance information for the vegetated swales:

Routine Action: Height of Vegetation

Maintenance Indicator:	Height of vegetation exceeds 12”
Field Measurements:	Visual Inspection
Inspection Frequency:	- Once per Wet Season - Once per Dry Season
Maintenance Activity:	Cut vegetation to 6”
Additional:	Remove any trees or woody vegetation

Routine Action: Assess Vegetative Cover

Maintenance Indicator:	Less than 70% vegetation coverage
Field Measurements:	- Visual Inspection - Record barren areas - File as a persistent problem
Inspection Frequency:	- Every May - Late each Wet Season - Late each Dry Season
Maintenance Activity:	- Reseed/re-vegetate barren areas by November - Scarify area to restored and replant to 2" height - If this is required two (2) seasons in a row then an erosion blanket will need to be installed prior to the third reseeding/re-vegetation.

Routine Action: Inspect for Debris Accumulation

Maintenance Indicator:	Debris or litter present
Field Measurement:	Visual Inspection
Inspection Frequency:	Periodic
Maintenance Activity:	Remove debris and trash and dispose of properly

Routine Action: Inspect for Accumulated Sediment

Maintenance Indicator:	- Sediment at or near vegetation height - Channeling of flow - Inhibited flow due to shallow slope
Field Measurement:	Visual Inspection
Inspection Frequency:	Annual
Maintenance Activity:	- Remove sediment - If flow is channeled, determine cause and correct - If sediment is deep enough to change flow gradient then remove all sediment during the dry season (May) and re-vegetate. Notify the City Engineer to determine if re-grading is required.

Routine Action: Inspect for Burrows

Maintenance Indicator:	Burrows, holes or mounds
Field Measurement:	Visual Inspection
Inspection Frequency:	- Annual - After vegetation trimming
Maintenance Activity:	Backfill burrows where seepage, erosion or leakage occur

Routine Action: General Maintenance Inspection

Maintenance Indicator:	Any damaged aspects (side slopes, inlet)
Field Measurement:	Visual Inspection
Inspection Frequency:	- Late each Wet Season - Late each Dry Season
Maintenance Activity:	Take corrective action prior to wet season

EXTENDED DETENTION (DRY) BASIN

The following is inspection and maintenance information for the extended detention (dry) basin:

Routine Action: Side Slopes

Maintenance Indicator:	Average vegetation height is greater than 12-inches, emergence of trees or woody vegetation
Field Measurements:	- Visual Inspection - Random side slope measurements
Inspection Frequency:	- Once per Wet Season - Once per Dry Season
Maintenance Activity:	Cut vegetation to 6-inches and remove trimmings and remove any trees or woody vegetation.

Routine Action: Slope Stability

Maintenance Indicator:	Evidence of erosion
Field Measurements:	- Visual Inspection
Inspection Frequency:	October of each year
Maintenance Activity:	- Reseed/revegetate barren spots prior to wet season - Contact Environmental or landscape architect for appropriate seed mix - Scarify surface if needed - If after two applications (2 seasons) of reseeding/revegetating and growth is unsuccessful both times, an erosion blanket (or approved equivalent) will be installed over eroding areas. No erosion blankets are to be installed in or around the basin invert.

Routine Action: Inspect for Standing Water

Maintenance Indicator:	Standing water for more than 72 hours
Field Measurements:	- Visual Inspection - Random side slope measurements
Inspection Frequency:	- Annually - 72 hours after a target storm event (0.75 inches)
Maintenance Activity:	- Drain facility - Check and unclog clogged orifice(s) - Notify engineer, if immediate solution is not evident.

Routine Action: Inspection fro Trash and Debris

Maintenance Indicator:	Debris/trash present
Field Measurements:	- Visual Observation
Inspection Frequency:	- During routine inspections
Maintenance Activity:	Remove and dispose of trash and debris

Routine Action: Inspection for Sediment Management and Characterization of Sediment for Removal

Maintenance Indicator:	Sediment depth exceeds marker on staff gage
Field Measurements:	- Measure depth at apparent maximum and minimum accumulation of sediment - Calculate average depth
Inspection Frequency:	- Annually
Maintenance Activity:	- Remove and properly dispose of sediment - Re-grade if necessary

Routine Action: Inspect for Burrows

Maintenance Indicator:	Burrows, holes or mounds
Field Measurement:	Visual Inspection
Inspection Frequency:	- Annual - After rock re-distributions
Maintenance Activity:	Backfill burrows where seepage, erosion or leakage occurs and re-distribute rock

Routine Action: General Maintenance Inspection

Maintenance Indicator:	- Inlet structures, outlet structures, side slopes, or other features damaged, significant erosion, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.
Field Measurements:	- Visual Inspection
Inspection Frequency:	- Semi Annually - Late wet season - Late dry season (monthly)
Maintenance Activity:	- Take corrective action prior to wet season - Consult engineers if immediate solution is not evident

BMP INSPECTION FORM

GENERAL INFORMATION				
Project Name				
City Contract No				
Contractor				
Inspector's Name				
Inspector's Title				
Signature				
Date of Inspection				
Inspection Type (Check Applicable)	r Prior to forecast rain r 24-hr intervals during extended rain		r After a rain event r Other ____________	
Season (Check Applicable)	r Rainy (Wet)		r Non-Rainy (Dry)	
Storm Data	Storm Start Date & Time:		Storm Duration (hrs):	
	Time elapsed since last storm (Circle Applicable Units)	Min. Hr. Days	Approximate Rainfall Amount (mm)	

NOTES: ____

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INSPECTION REQUIREMENTS				
Requirement	**Yes**	**No**	**N/A**	**Corrective Action**
Vegetated Swales				
Is the height of vegetation less than 12"?				
Is the vegetation coverage 70% or more?				
Is there debris or litter present?				
Is the channel sedimented?				
Are there burrows, mounds, or holes present?				
Is there any damage to the vegetated swales?				
Extended Detention (Dry) Basin				
Is the height of vegetation less than 12"?				
Has any standing water been present for more than 72 hours?				
Is there any trash or debris present?				
Is there any accumulated sedimentation in the basin?				
Is there any slope erosion?				
Are there burrows, mounds, or holes present?				
Is there any damage to any of the basin features?				

NOTES: ____

STORM WATER MANAGEMENT PLAN
FOR PRIORITY PROJECTS
(MAJOR SWMP)

ATTACHMENT E

CERTIFICATION SHEET

This Stormwater Management Plan has been prepared under the direction of the following Registered Civil Engineer. The Registered Civil Engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

3 - 19 - 08

GARY WYNN
REGISTERED CIVIL ENGINEER

DATE

Registered Professional Engineer
Gary R. Wynn
No. C043202
Exp. 3-31-10
Civil
State of California